Landslide Hazard Assessment in Central America

Dalia Kirschbaum, Code 617, NASA GSFC

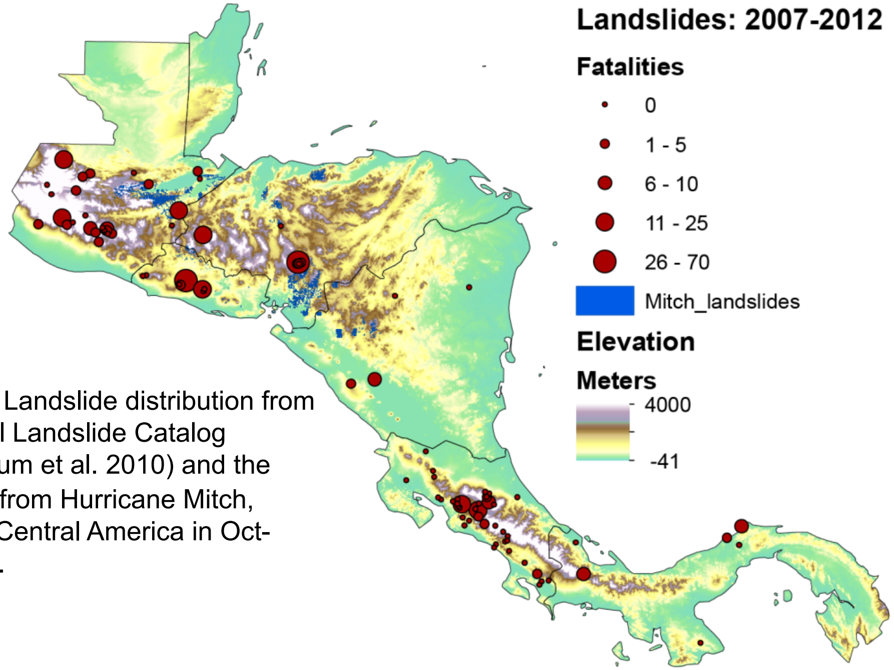
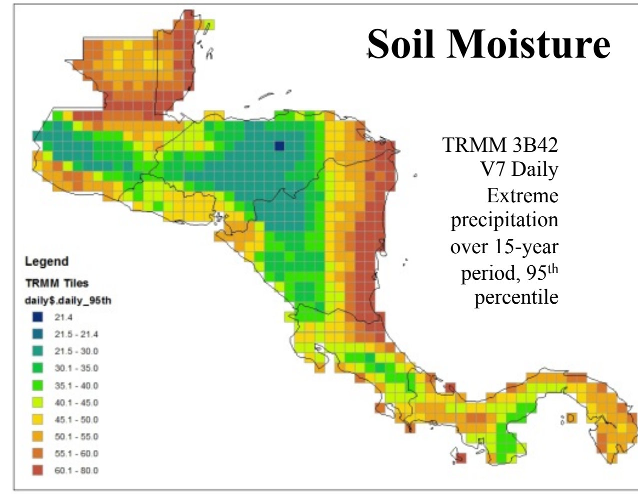
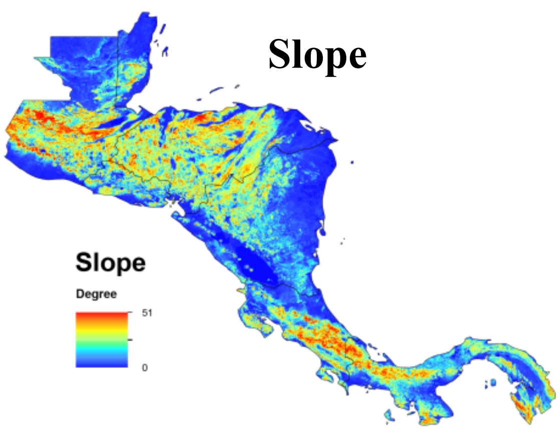
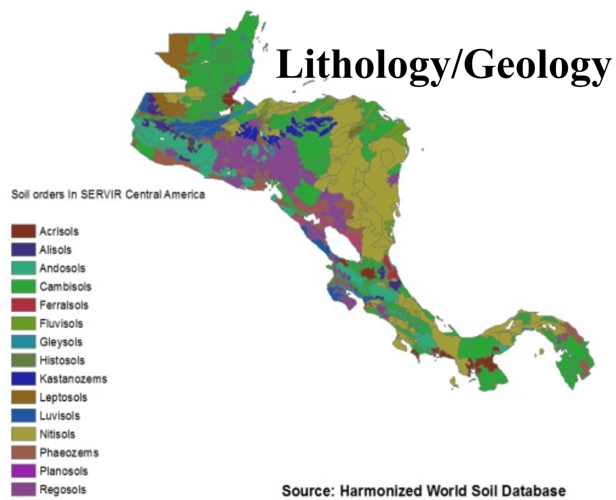


Figure 1: Landslide distribution from the Global Landslide Catalog (Kirschbaum et al. 2010) and the inventory from Hurricane Mitch, which hit Central America in Oct-Nov 1998.







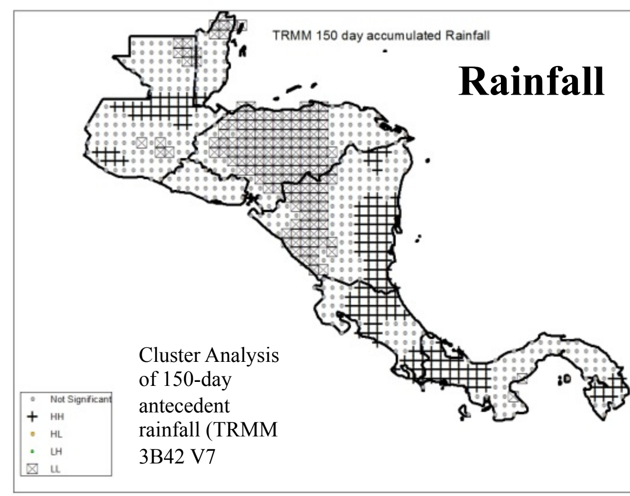


Figure 2: Landslide hazard assessment and forecasting system that utilizes primarily remotely sensed data to estimate and anticipate areas of landslide potential in this region. The model linearly combines susceptibility values for slope and lithology/geology as physical static parameters (left) and then updates rainfall and soil moisture information sub-daily as available (right).

Name: Dalia Kirschbaum, Code 617, NASA GSFC
E-mail: dalia.b.kirschbaum@nasa.gov
Phone: 301-614-5810

Abstract: Landslides in Central America frequently cause fatalities, economic damage and disrupt transportation networks (Fig. 1). Quantifying both *where* and *when* landslides may impact an area is challenging due to limitations in detailed surface data (e.g. soils, soil moisture, topography, lithology), sparse landslide inventory information and limitations in accurately estimating rainfall triggers.

This research presents the framework for a new landslide hazard assessment and forecasting system for the SERVIR-Mesoamerica node that can be used to both identify landslide-prone areas and forecast the potential location and timing of landslide initiation in the future (Fig. 2). This system expands upon existing modeling efforts to create a robust landslide hazard assessment system with the goal of better informing decision-making and disaster response activities at a regional scale.

References:

Hong, Y., Adler, R., & Huffman, G. (2007). Use of satellite remote sensing data in the mapping of global landslide susceptibility. *Natural Hazards*, *43*(2), 245–256. doi:10.1007/s11069-006-9104-z

Kirschbaum, D. B., Adler, R., Hong, Y., Hill, S., & Lerner-Lam, A. (2010). A global landslide catalog for hazard applications: method, results, and limitations. *Natural Hazards*, *52*(3), 561–575. doi:10.1007/s11069-009-9401-4

Kirschbaum, D. B., Adler, R., Hong, Y., Kumar, S., Peters-Lidard, C., & Lerner-Lam, A. (2012). Advances in landslide nowcasting: evaluation of a global and regional modeling approach. *Environmental Earth Sciences*, *66*(6), 1683–1696. doi:10.1007/s12665-011-0990-3

Mora, S. C., & Vahrson, W.-G. (1994). Macrozonation Methodology for Landslide Hazard Determination. *Bulletin of the Association of Engineering Geologists*, *XXXI*(1), 49–58.

Verdin, K. L., Godt, J., Funk, C., Pedreros, D., Worstell, B., & Verdin, J. (2007). Development of a Global Slope Dataset for Estimation of Landslide Occurrence Resulting from Earthquakes. *U.S. Geological Survey*, *Open-File* , 1–29.

Data Sources: Shuttle Radar Topography Mission (SRTM) digital elevation model, Global Landslide Catalog, several state or regionally-based landslide inventories, Harmonized World Soils Data, TRMM 3B42 V7

Technical Description of Images: The regional landslide hazard map buildings upon a concept developed by Mora and Vahrson (1994) which weights different input variables according to their relative susceptibility to landslide activity. This modified framework incorporates both static (slope & lithology/geology) and dynamic (rainfall & soil moisture) variables to approximate potential landslide activity in near-real time. This work builds a set of products and a model framework that can then be expanded to address questions of population exposure, seismicity, burned areas, etc. This work will also develop a forecasting component in order to extend the model to allow for a "warning/watch" landslide alert. The model will be validated with available inventories within Central America (**Figure 1).**

Figure 2 illustrates the general framework of the model. The intent of the landslide framework is that is both straightforward to implement and understand, allowing end users within the region to easily adopt the model for their own emergency response purposes. The model combines susceptibility values for slope (USGS 1km product derived from SRTM 90m) and lithology/geology (developed through a combination of frequency analysis and surveys from local experts to suggest susceptibility values). This static map is then integrated with near real-time rainfall (TRMM 3B42V7 RT thresholds) and soil moisture (Real-time Modeled Soil Moisture Products or Antecedent Precipitation information) sub-daily as available The model focuses on developing this prototype framework over the SERVIR-Mesoamerica Nodes; however, given the simple framework and use of nearly all global data products, the ultimate project goal is to transfer this system to other SERVIR Nodes and eventually apply it at the global scale. This system uses a modified Mora-Vahrson approach (Mora and Vahrson 1994).

Scientific Significance: While regional monitoring systems for hurricanes, extreme precipitation, and earthquakes exist, there currently is not an operational system for all of Mesoamerica that identifies potentially susceptible areas to landslides in near real-time using precipitation inputs, surface conditions and antecedent rainfall. Such a tool is critically needed by government agencies, non-governmental organizations, academic researchers and the general public to inform at-risk communities about potential impacts of landslides within their area. Furthermore, the applicability of satellite data enables this model to be applied homogeneously over Mesoamerica and establishes an easily-transferable framework to other regions.

Relevance for future science and relationship to Decadal Survey: Precipitation information from TRMM and the upcoming Global Precipitation Measurement (GPM) mission (www.gpm.nasa.gov) will help to relate static landslide susceptibility information ("where" landslides may occur) to precipitation triggers ("when" landslides may be triggered). Soil moisture information, such as from the SMAP mission will also provide important clues to antecedent soil moisture status, allowing us to discern whether a previous rainfall event may play a role in future landslide activity.